



## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>5</sup> :</b> <b>C08K 5/11</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 92/15640</b> <b>(43) International Publication Date:</b> 17 September 1992 (17.09.92)
<b>(21) International Application Number:</b> PCT/US92/01210 <b>(22) International Filing Date:</b> 14 February 1992 (14.02.92) <b>(30) Priority data:</b> 664,927 5 March 1991 (05.03.91) US <b>(71) Applicant:</b> POLYMERIX, INC. [US/US]; 777 Walnut Avenue, Cranford, NJ 07016 (US). <b>(72) Inventors:</b> MACK, Wolfgang, A. ; 959 Scioto Drives, Franklin, NJ 070417 (US). CANTERINO, Peter, J. ; 39 Mary Drive, Towaco, NJ 07082 (US). <b>(74) Agents:</b> LEWEN, Bert, J. et al.; Darby & Darby, 805 Third Avenue, New York, NY 10022 (US).		<b>(81) Designated States:</b> AT (European patent), AU, BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), MC (European patent), NL (European patent), SE (European patent).  <b>Published</b> <i>With international search report.</i> <i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>
<b>(54) Title:</b> EXTRUSION METHOD AND APPARATUS FOR RECYCLING WASTE PLASTICS AND CONSTRUCTION MATERIALS THEREFROM  <b>(57) Abstract</b>  An extrudable composition comprised of waste polyolefins and an alkali metal bicarbonate salt/solid, saturated fatty acid foaming agent system, and a method for extruding such extrudable composition wherein the fatty acid/bicarbonate foaming agent system foams the waste polyolefins during the extrusion to produce end products which have qualities closely simulating natural lumber suitable for use as construction materials.		

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FI	Finland	ML	Mali
AU	Australia	FR	France	MN	Mongolia
BB	Barbados	GA	Gabon	MR	Mauritania
BE	Belgium	GB	United Kingdom	MW	Malawi
BF	Burkina Faso	GN	Guinea	NL	Netherlands
BG	Bulgaria	GR	Greece	NO	Norway
BJ	Benin	HU	Hungary	PL	Poland
BR	Brazil	IE	Ireland	RO	Romania
CA	Canada	IT	Italy	RU	Russian Federation
CF	Central African Republic	JP	Japan	SD	Sudan
CG	Congo	KP	Democratic People's Republic of Korea	SE	Sweden
CH	Switzerland	KR	Republic of Korea	SN	Senegal
CI	Côte d'Ivoire	LI	Liechtenstein	SU	Soviet Union
CM	Cameroon	LK	Sri Lanka	TD	Chad
CS	Czechoslovakia	LU	Luxembourg	TG	Togo
DE	Germany	MC	Monaco	US	United States of America
DK	Denmark	MG	Madagascar		
ES	Spain				

5

10        EXTRUSION METHOD AND APPARATUS FOR RECYCLING WASTE PLAS-  
         TICS AND CONSTRUCTION MATERIALS THEREFROM

BACKGROUND OF THE INVENTION

15                The invention is directed to an extrudable  
                 compound, an extrusion method using primarily waste  
                 polyolefin starting materials, and articles manufactured  
                 through such processes which simulate conventional outdoor  
                 construction lumber.

20                There are many advantages to recycling waste  
                 plastics both economical and ecological. Discarded waste  
                 plastics are available at comparatively negligible costs  
                 since they are essentially garbage. Furthermore, the present  
                 invention provides an economic incentive to remove waste  
25                plastics, which ordinarily are not completely biodegradable,  
                 from the environment.

                 Waste polyolefins and other waste plastics are dif-  
                 ferent from plastics fresh off a plastic manufacturer's  
                 production line because these materials have served their  
30                intended use, been discarded and exposed, often for lengthy  
                 periods, to the environment. This relatively lengthy  
                 exposure to the elements produces changes in the physical and  
                 chemical properties of the plastics. Generally, waste  
                 plastics have lower tensile strength and relatively poorer  
35                flex and thermal properties when compared to new plastics  
                 fresh off the production line.

**SUBSTITUTE SHEET**

Since waste polyolefins are not completely biodegradable, they have life cycles which are much longer than conventional wooden building materials. In addition, construction materials made from waste polyolefins have chemical, biological, mechanical, electrical and flame resistance properties superior to counterpart natural lumber products.

Surprisingly, only limited attempts have been made to develop lumber-substitute construction products from waste polyolefins. For example, U.S. Patent No. 4,003,866 teaches construction material made from waste thermoplastic resins and other non-plastic fillers. The non-plastic fillers are coated or encapsulated with a recycled polyethylene or polypropylene wax. Because of the complexity of the process disclosed and the limited improvement provided by the wax encapsulated materials over natural materials, the products made from this disclosure have very narrow practical application.

Maczko, J., A System to Mold Mixed, Contaminated Plastics into Wood, Metal and Concrete Replacements, RECYCLINGPLAS II, Conference of Plastics Institute of America, June 18-19, 1987, Washington, D.C., describes the ET-1 process for producing substitute construction materials from waste plastics. The described method is claimed to be able to transform mass waste plastics directly into a large range of molded end products without presorting of any kind, and without the need for inserting any additives to the intermediate resin.

The ET-1 process melts resins in a short-screw extruder, then forces the heated extrudate into a series of linear molds which are then mounted onto a turret. The heated molds cool as the turret rotates them through a water filled tank. The end products are air-ejected from open ends of the molds.

The ET-1 end product is essentially a solid with

randomly spaced voids. It has a typical specific gravity slightly higher than 1.0 gm/cc, making it heavier than most natural timber products (ordinarily, wood floats on water because it has a density less than that of water). The length of the end products are limited by the size of the mold into which the extruder can inject and fill with resin. Practically, as construction material, these end products are generally difficult to cut, saw, nail or drill holes into.

Accordingly, there is a need for a recycled waste plastic material which has qualities closely resembling natural lumber such as consistency, texture and density which will be readily accepted by the construction industry as a replacement for wood. Such materials can be used by architects, construction engineers and manual construction laborers by applying their currently known skills to the use of such recycled waste plastic products.

Known extrusion methods have not been able to satisfactorily convert waste plastics into products that have uniform dimension due to variations in the feed composition, and the end products produced, undesirably and unpredictably, vary in size, configuration and thickness. The need therefore exists for an extrusion process which produces end products derived from waste plastics with substantially uniform dimensions conforming to conventional construction standards of any desired length.

#### SUMMARY OF THE INVENTION

To overcome the problems and deficiencies of the currently available art, the present invention provides an improved, extrudable composition; an extrusion method for continuously producing improved composites from waste polyolefins; and the improved, composite end product which closely resembles construction lumber.

The extrudable composition used as the starting material contains at least 50t waste polyolefin; from 0.1t to 1.5t of a Group IA alkali metal bicarbonate; and from 0.6 to

2.0 molar equivalents of the bicarbonate salt, of a saturated fatty acid, which is solid at room temperature (20°C, 1 atm). The preferred alkali metal salts are sodium or potassium bicarbonate. Suitable saturated fatty acids include those  
5 with carbon chains of from 14 to 22 carbons such as myristic acid, palmitic acid, stearic acid, arachidic acid, and mixtures, such as tallow fatty acids. The preferred foaming agent system is a sodium bicarbonate/solid stearic acid combination.

10 The foaming agent components react in situ in the waste polyolefin to form products which serve several functions. Using, the preferred system, for example, in addition to the formation of CO<sub>2</sub> for foaming, sodium stearate is formed by the reaction of the sodium bicarbonate with the  
15 stearic acid. Sodium stearate, along with unreacted stearic acid, helps disperse the filler materials during extrusion. The stearate also lubricates the melt in the extruder as the semisolid mass passes through the sizing sleeve, reducing "seizing" and sticking. The sodium stearate present in the  
20 final product also acts as a hydrogen chloride scavenger, and as an anionic compound which helps "bleed off" static charges which may otherwise build up during actual use of the end product.

The extruded products have a specific gravity of  
25 from 0.4 gm/cc to 0.9 gm/cc, in contrast to conventional recycled waste plastic compositions which generally have specific gravities in excess of 1.0 gm/cc. The foaming serves to reduce the density in the final product thereby saving the amount of raw materials required for a given  
30 volume and increases the strength-to-weight ratios of the end-products.

In the extrudable composition, the preferred resin is that obtained by grinding post-consumer mixed plastics containing mainly polyolefins. The term "polyolefins" as  
35 used herein refers to HDPE, LDPE, LLDPE, UHMWPE, homopolymers

of polypropylene, copolymers of ethylene and propylene, and combinations thereof.

"Waste polyolefins" as the term is used herein, contains at least 80% by weight polyolefins as defined above and, additionally, up to 20% by weight of one or more other polymeric materials such as rigid or flexible PVC; polystyrene; chloro-sulfonated polyethylenes; unmodified, compounded, reinforced, alloys or blends of engineering plastics such as polyamides, polycarbonates, thermoplastic polyesters (PET or PBT), ABS, polyphenylene oxide and polyacetals; and combinations thereof.

As is evident from the preceding, the waste polyolefins used as the starting materials for the present invention are a heterogeneous mixture of a wide range of plastics. They are obtained from industrial, commercial and residential garbage by initially removing the bulk of non-plastic contaminants such as dirt, spoiled food, paper, cloth and metals.

The compositions of the present invention may also include fibrous reinforcing agents for providing strength and improved impact properties to the molded end products, and filler materials for providing stiffness, additional strength, and enhanced mechanical and heat resistance. The reinforcing agent can be present in amounts from 0 to 50W of total weight of the composition, preferably at least 20W of total weight; and the filler materials from 0 to 20W of total weight, preferably at least 5W of total weight of the composition. Both the reinforcer and the filler content are adjusted to the type and quality of end product desired.

The preferred reinforcing agent is chopped strands of glass fiber. Appropriate coupling agents, such as silanes or organo-titanates, can also be used to enhance reinforcement.

Filler materials which can be used include calcium carbonate, asbestos, mica, wollastonite, talc, diatomaceous

**SUBSTITUTE SHEET**

earth, kaolin clays, alumina trihydrates, calcium  
metasilicate, metal flakes, ceramics, carbon filaments and  
the like. A single filler or a combination of fillers can be  
added, and the filler can also be derived from recyclable  
5 waste.

#### DETAILED DESCRIPTION OF THE INVENTION

The extrusion apparatus used in the invention  
includes a feeding section, a mixing section, and a shaping  
10 section.

When waste polyolefins are finely sorted (i.e. a  
relatively more detailed presorting for impurities such as  
paper, dirt, spoiled food, metals and non-waste-polyolefins  
is performed), the feeding section, which includes a  
15 shredder, can be eliminated, and the presorted waste  
polyolefins can be fed directly into the mixing section.

The mixing section includes a hopper, a reinforcing  
agent storage container, a foaming agent storage container,  
and an extruder. Channels provide for communication between  
20 the input end of the hopper and storage containers. The  
discharge end of the hopper communicates with an opening in  
the extruder.

The reinforcing agent is introduced from a storage  
container into the waste polyolefins. Filler materials can  
25 also be added at this point.

The extruder has a conventional screw which rotates  
to force the waste polyolefin stream out of the discharge end  
of extruder and into the die of the shaping section. The  
screw also functions to further mix the foaming agent and  
30 reinforcing agent with the waste polyolefin stream. The  
extruder has a conventional heating means to convert the  
waste polyolefin stream into a molten state.

When relatively finer pre-sorted waste polyolefins  
are involved, the polyolefins are introduced directly into  
35 the hopper. If the feed is composed of many different types



of waste polyolefins (as defined above), they can be dry-blended before being introduced into the extruder. The waste polyolefin stream can alternatively be preblended with the reinforcing agent and the foaming agent system prior to  
5 introduction into the hopper.

Turning now to the shaping section which is disposed downstream of the mixing section, it includes a die, a die extension communicating with the die, a sizing sleeve, and a puller or take away means. The extrudate emerging from  
10 the extruder is forced through the die and the die extension by the screw of the extruder. Most of the foaming occurs in the die extension. The sizing sleeve, disposed downstream of the die extension, is dimensioned so that its inside diameter corresponds to the maximum desired outside diameter of the  
15 end product.

The puller operates to pull the extrudate through the sizing sleeve. The puller can be of any conventional type such as a plurality of rollers which grip the extrudate therebetween. The sizing sleeve is immersed in a water  
20 trough, as is known in the art, to cool the extrudate and to rigidify it as it exits from the sizing sleeve.

As stated above, use of the foaming agent in the present method enables the production of a recycled plastic which has wood-like densities evenly and continuously distributed throughout the end-product, and which can be  
25 extruded to any desirable dimension. These composites can be nailed, screwed, sawed and bolted with conventional woodworking tools and skills, and unlike wood, these products will not rot and degrade when exposed to the environment and  
30 the strength of the product will remain constant whether wet or dry.

The end-product compositions of the present invention do not require addition of conventional stabilizers to protect against thermo-oxidative degradation, because the  
35 polymer resin matrix derived from waste plastics generally

contains stabilizers. Random samplings of collected waste plastics contain from 0.05 to 0.5%- stabilizer based on the total polymer resin matrix. However, the invention contemplates addition of useful stabilizers such as those  
5 well known in the art if necessary.

To the compositions of this invention there may additionally be added ultraviolet absorbers and antifungal agents, depending on the ultimate intended use of the extruded product.

10 In addition to extrusion, the compositions of this invention may be injection molded to produce commercially usable products. To such ends, other additives can be used, including impact modifiers, viscosity stabilizers, processing aids, and coloring agents.

15 The following examples demonstrate the actual production of the compositions of the present invention.

EXAMPLE 1

Initially, a comparative study was performed using various forms of organic acid/sodium bicarbonate foaming  
20 agent systems. As this example demonstrates, the stearic acid system showed the lowest density end product.

To one pound of high density polyethylene was added the following organic acids with a stoichiometric equivalent, (4.52 gm) of sodium bicarbonate. The two ingredients were  
25 dry blended with the polyethylene. The blends were then extruded by the use of a 1-inch extruder with the following temperature profile: the melting zone, 200°C; the pumping/metering zone 180-210°C; and die temperature, 200°C.

Sample strands of final product were collected and  
30 their specific gravities measured. The results are summarized in the following table:

TABLE 1

	<u>Sample</u> (gm/cc)	<u>Organic acid (gm)</u>	<u>Specific gravity of foam</u>
5	control	---	0.95
	stearic acid	14.7	0.47
	isophthalic acid	4.5	0.62
	benzoic acid	6.1	0.60
	citric acid	4.5	0.80

10

EXAMPLE 2

A masterbatch of foaming agent was prepared by mixing the following ingredients in the following ratios:

	Parts
15 Mica (carrier/filler material)	50.0
NaHCO <sub>3</sub>	3.0
Stearic Acid	9.0

In a twin screw extruder (Berstorff ZE 40-A) was fed a blend of 25% glass fibers and 72%, high density polyethylene (0.7 melt index, 0.96 gm/cc). As a side feed, 4% of masterbatch was added (to give 0.2 and 0.6 weight t foaming agent, NaHCO<sub>3</sub>-stearic acid). The melt was forced through a die and a sizing sleeve and into a water trough to give a 2 x 4 inch extruded structure resembling wood. The expected specific gravity for high density polyethylene with 25% glass fiber was 1.2 gm/cc. Surprisingly, the density of the extrudate was found to be 0.69 gm/cc. Smooth extrusion with good filler dispersion was observed. Evenly distributed, uniform foam structure was observed during extruding.

EXAMPLE 3

Commingled waste polyolefin plastic containers randomly obtained from household, curb-side garbage, after substantial separation of PET carbonated beverage containers,

were put through a grinder and reduced to flake.

A masterbatch foam system of the following composition was prepared by mixing the following ingredients in the following ratios:

- 5        50.0 parts ground mollusk shells (97.5%  $\text{CaCO}_3$ )  
          9.0 parts stearic acid  
          3.0 parts sodium bicarbonate

The following components were fed to a twin-screw 60 mm extruder:

10		<u>PARTS</u>	
	Ground waste polyolefin flakes		70.0
	Glass fibers	20.0	
	Masterbatch foam system	10.0	

- The three ingredients were metered separately,
- 15 the  
ground polyolefin flakes at the throat of the extruder, and  
the  
glass fiber and masterbatch through a side-feeder at a point  
where the resin was molten. The total feed was 300 lbs/hr.
- 20 A smooth extrusion with no sticking in the sizing sleeve and  
a good dispersion of the glass fibers and ground mollusk  
shells materials was observed. The density of the  
continuously extruded end-product over an 8 hour period was  
between 0.73 to 0.88 gm/cc.

25

#### EXAMPLE 4

- A series of compositions were made using various  
fillers and resin blends using the same rates as in Example  
3. The resulting densities of these compositions are shown in
- 30 Tables 2 and 3. The numerals which precede percentage symbols  
denote the percentage concentration of that particular in-  
gredient relative to the total weight of the end products.

TABLE 2

5	COMPOSITION NO.:	1	2	3	4	5
	<u>INGREDIENT</u>					
10	WASHED WASTE POLYOLEFIN			71.9%		
	UNWASHED WASTE POLYOLEFIN	71.9%	71.9%	56.7%		61.9%
15	POLYSTYRENE 10.0%**		15.2%*			
20	WASTE GLASS FIBER	20.0%	20.0%	20.0%	20.0%	
	PRIME GLASS FIBER	20.0%				
25	GROUND OYSTER SHELLS	6.5%	6.5%	6.5%	6.5%	6.5%
	STEARIC ACID	1.2%	1.2%	1.2%	1.2%	1.2%
30	SODIUM BICARBONATE	0.4%	0.4%	0.4%	0.4%	0.4%
35	DENSITY gm/cc.	0.78	0.77	0.79	0.80	0.78
	* Crystalline polystyrene					
40	** Expandable polystyrene					

SUBSTITUTE SHEET

TABLE 3

COMPOSITION NO.:		6	7	8	9	10
<u>INGREDIENT</u>						
10	GROUND WASTE POLYOLEFIN	37.3%	34.8%	71.9%	71.9%	71.9%
	GROUND WASTE POLYPROPYLENE	34.6%	34.6%			
15	GLASS FIBERS	20.0%	20.0%	20.0%	20.0%	20.0%
	DIATOMACEOUS EARTH				6.5%	
20	GROUND OSYTER SHELLS (97.5% CaCO <sub>3</sub> )	6.5%	6.5%	6.5%	6.5%	
25	EMULSIFYABLE POLYETHYLENE WAX		2.5%			
	STEARIC ACID	1.2%	1.2%	1.2%	1.2%	1.2%
30	SODIUM BICARBONATE	0.4%	0.4%	0.4%	0.4%	0.4%
35	DENSITY gm/cc.	0.82	0.86	0.72	0.78	0.75

It will be appreciated that the instant specification and claims are set forth by way of illustration and not limitation, and that various modifications, additions or substitutions may be made without departing from the spirit and scope of the present invention.

**CLAIMS:**

1                   1.    An extrudable composition for making  
2   construction material, comprising a dry blend of:  
3                    at least 50%-, based on total weight of said  
4   composition, of a used polyolefinic material derived from  
5   residential, commercial, or industrial waste;  
6                    about 0.1 to 1.5t, based on the total weight  
7   of said composition, of an alkali metal bicarbonate; and  
8                    in a ratio of about 0.6 to 2.0 molar  
9   equivalents with respect to said bicarbonate, a saturated  
10  fatty acid which is a solid at room temperature, the amount  
11  of said alkali metal bicarbonate and said fatty acid being  
12  sufficient to fo=, upon extrusion, a foamed construction  
13  material having a specific gravity of 0.4 to 0.9.

1                   2.    The composition of claim 1 wherein said  
2   polyolefinic material is high density polyethylene.

1                   3.    The composition of claim 1 wherein the  
2   polyolefinic component of said waste polyolefinic material is  
3   HDPE, LDPE, LLDPE, UHMWPE, a homopolymer of polypropylene, a  
4   copolymer of ethylene and propylene or mixtures thereof.

1                   4.    The composition of claim 3 wherein said waste  
2   polyolefinic material contains a non-polyolefinic component  
3   comprising rigid PVC, flexible PVC, chloro-sulfonated poly-  
4   ethylene, polyamide, polycarbonate, PET thermoplastic polyes-  
5   ter, PBT thermoplastic polyester, ABS, polyphenylene oxide,  
6   polyacetal or a mixture thereof.

1                   5.    The composition of claim 4 wherein said non-  
2   polyolefinic component is from about 0.5t to about 20%- by  
3   total weight of said composition.

1                   6.    The  
2   composition of claim 1 wherein said fatty acid is selected  
3   from the group consisting of myristic acid, palmitic acid,  
4   stearic acid, arachidic acid and mixed tallow fatty acids

1                   7.    The composition of claim 1 wherein said alkali  
2   metal bicarbonate is sodium bicarbonate or potassium bicar-

**SUBSTITUTE SHEET**

3 bonate.

1       8.    The composition of claim 1 further comprising:  
2            a glass fiber reinforcing agent; and  
3            a filler of calcium carbonate, asbestos, mica,  
4 wollastonite, talc, diatomaceous earth, kaolin clays, alumina  
5 trihydrates, calcium metasilicate, metal flakes, ceramics, or  
6 carbon filaments.

1           9.    The composition of claim 8 wherein said filler  
2 is present in an amount between about 8% to 20% of total  
3 weight of said extrudable composition.

1           10.   The composition of claim 8 wherein said rein-  
2 forcing agent is present in an amount of between about 2% to  
3 50% of total weight of said extrudable composition.

1           11.   A foam composition having a specific gravity  
2 of  
3 0.4 to 0.9 formed by a continuous extrusion process and  
4 suitable for use as a substitute for construction lumber,  
5 comprising;

6                at least 50%, based on total weight of said  
7 composition, of a used polyolefinic material derived from  
8 residential, commercial, or industrial waste; and

9                an anionic salt of an alkali metal carboxylate  
10 of a saturated fatty acid.

1           12.   The extruded composition of claim 11 wherein  
2 said fatty acid is myristic acid, palmitic acid, stearic  
3 acid, arachidic acid or a mixed tallow fatty acid.

1           13.   The extruded composition of claim 11 wherein  
2 the polyolefinic component of said waste polyolefinic  
3 material is high density polyethylene.

1           14.   The extruded composition of claim 11 further  
2 comprising:

3 a glass fiber reinforcing agent; and a filler of calcium  
4 carbonate, asbestos, mica, wollastonite, talc, diatomaceous  
5 earth, kaolin clay, alumina trihydrate, calcium metasilicate,  
6 metal flakes, ceramics, or carbon filaments.

**SUBSTITUTE SHEET**



1           15. The extruded composition of claim 11 wherein  
2 said alkali metal is sodium or potassium.

1           16. The extruded composition of claim 11 wherein  
2 the polyolefinic component of said waste polyolefinic  
3 material is HDPE, LDPE, LLDPE, UHMWPE, a homopolymer of  
4 polypropylene, or a copolymer of ethylene and propylene or  
5 mixtures thereof.

1           17. The extruded composition of claim 16 wherein  
2 said waste polyolefinic material contains a non-polyolefinic  
3 component comprising rigid PVC, flexible PVC,  
4 chloro-sulfonated polyethylene, polyamide, polycarbonate, PET  
5 thermoplastic polyester, PBT thermoplastic polyester, ABS,  
6 polyphenylene oxide, polyacetal or mixtures thereof.

1           18. The extruded composition of claim 17 wherein  
2 from about 0.5% to about 20% by total weight of said composi-  
3 tion of said non-polyolefinic component is present.

1           19. The extruded composition of claim 14 wherein  
2 said filler is present in an amount between about 5% to 20%  
3 of total weight of said composition.

1           20. The extruded composition of claim 14 wherein  
2 said reinforcing agent is present in an amount between about  
3 2% to 50% of total weight of said composition.

1           21. A method for making a composite foam extruded  
2 product which simulates lumber comprising the steps of:

3               continuously supplying to an extruder used  
4 polyolefinic material derived from residential, commercial,  
5 or industrial waste;

6               blending with said polyolefinic material an alkali  
7 metal bicarbonate and a saturated fatty acid which is a solid  
8 at room temperature, said bicarbonate being at a  
9 concentration of about 0.1 to 1.5% of total weight of said  
10 blend and said fatty acid being in a molar ratio of from  
11 about 0.6 to 2.0 with respect to said bicarbonate;

12               extruding a melt of said blend through a  
13 profile die;

14 forming a foaming agent and a lubricant for said  
15 blend by the in situ reaction of said bicarbonate and said  
16 fatty acid;

17 feeding the lubricated blend from said die into a  
18 sizing zone wherein the blend is foamed to substantially its  
19 final cross-section;

20 cooling the thus-foamed material in said  
21 sizing zone so as to rigidify the foamed material; and  
22 forcing and pulling the rigidified material through  
23 and from said sizing zone.

1 22. The method of claim 21 further comprising:  
2 adding a glass fiber reinforcing agent and a filler material  
3 to said extruder, said filler material being calcium  
4 carbonate, asbestos, mica, wollastonite, talc, diatomaceous  
5 earth, kaolin clay, alumina trihydrate, calcium metasilicate,  
6 metal flakes, ceramics, or carbon filaments.

1 23. The method of claim 21 wherein said fatty acid  
2 is myristic acid, palmitic acid, stearic acid, arachidic acid  
3 or a mixed tallow fatty acid.

1 24. The method of claim 21 wherein said alkali  
2 metal bicarbonate is sodium bicarbonate or potassi-  
3 bicarbonate.

1 25. The method of claim 21 wherein the  
2 polyolefinic component of said waste polyolefins is high  
3 density polyethylene.

1 26. The method of claim 21 wherein the  
2 polyolefinic component of said waste polyolefins is HDPE,  
3 LDPE, LLDPE, UHMWPE, a homopolymer of polypropylene, a  
4 copolymer of ethylene and propylene or mixtures thereof.


1 27. The method of claim 26 wherein said waste  
2 polyolefins contains a non-polyolefinic component which is a  
3 rigid PVC, flexible PVC, chloro-sulfonated polyethylene,  
4 polyamide, polycarbonate, PET thermoplastic polyester, PBT  
5 thermoplastic polyester, ABS, polyphenylene oxide, polyacetal  
6 or a mixture thereof.

1                   28. The method of claim 27 wherein from about 0.5%  
2 to about 20t by total weight of said composition of said non-  
3 polyolefinic component is present.

**SUBSTITUTE SHEET**

# INTERNATIONAL SEARCH REPORT

International Application No PCT/US92/01210

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>3</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC IPC (5): C08K 5/11 U.S. Cl. 524/318		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>4</sup>		
Classification System	Classification Symbols	
U.S.	524/300, 318, 424; 521/79, 143	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>5</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup>		
Category <sup>6</sup>	Citation of Document, <sup>15</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>
Y	US, A, 4,650,816 (BERTRAND) 17 MARCH 1987; See entire document.	1-28
Y	US, A, 4,956,396 (KIM ET AL.) 11 SEPTEMBER 1990; See entire document.	1-28
Y	US, A, 4,588,754 (LIU) 13 MAY 1986; See entire document.	1-28
Y	US, A, 3,893,957 (MIXON ET AL.) 08 JULY 1975; See entire document.	1-28
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>*</sup> Special categories of cited documents: <sup>13</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p> </div> </div>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search <sup>2</sup>		Date of Mailing of this International Search Report <sup>2</sup>
18 JUNE 1992		07 JUL 1992
International Searching Authority <sup>1</sup>		Signature of Authorized Officer <sup>19</sup>
ISA/US		 Paul Michl

## FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE<sup>1</sup>

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons:

1. ☐ Claim numbers \_\_\_\_\_, because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers \_\_\_\_\_, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out<sup>1</sup>, specifically:

3. ☐ Claim numbers \_\_\_\_\_, because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING<sup>2</sup>

This International Searching Authority found multiple inventions in this international application as follows:

Group I: Claims 1-10 are directed to polymeric compositions classified in Class 524 Subclass 318.

(Con't.)

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all the claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report does not cover the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority does not invite payment of any additional fee.

## Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.

VI. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

Group II: Claims 11-28 are directed to an extrusion process and an extruded Product, classified in Class 264, subclass 54.

The claims of these two groups lack unity of invention under PCT Rule 13 since they are not so linked as to form a single inventive concept. The composition of Group I has uses other than as an extrusion compound.